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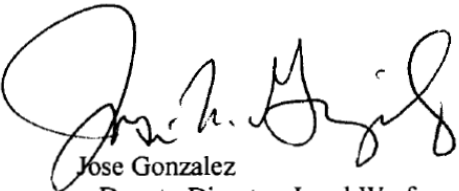
## **JOINT ORDNANCE TEST PROCEDURE (JOTP)-061**

### **HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO) SAFETY TEST**

**Joint Services Munition Safety Test Working Group**

Joint Ordnance Test Procedure (JOTP)-061  
Hazards of Electromagnetic Radiation to Ordnance (HERO) Safety Test

<b>DOCUMENT DATE:</b>  10 January 2013	<b>TITLE AND SUBTITLE:</b>  Joint Ordnance Test Procedure (JOTP)-061 Hazards of Electromagnetic Radiation to Ordnance (HERO) Safety Test
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<b>COORDINATION DRAFT REVIEWED BY:</b>  Naval Ordnance Safety and Security Activity (NOSSA)  DOD Joint Weapon Safety Working Group (JWSWG)  Joint Ordnance Commander's Group (JOCG) HERO Subcommittee	
<b>PATH FORWARD:</b>  This Joint Ordnance Test Procedure (JOTP) shall serve as the US Joint Services Hazards of Electromagnetic Radiation to Ordnance (HERO) Safety Test Procedures with regards to conventional munitions until which time the content of this document is included in the next revision of Department of Defense Manual (DoDM) 3222 (Electromagnetic Compatibility and Electronic Warfare), and Standardization Agreement (STANAG 4370)/Allied Environmental Conditions and Test Publication (AECTP) 500 (Electromagnetic Environmental Effects Test and Verification) Category 508 (Ordnance/Munitions Verification Testing). Upon approval of the next revisions of DoDM 3222 and STANAG 4370/AECTP 500, thorough review of this document shall be conducted with the intent to supersede.	

 2/4/13  
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Acquisition, Technology and Logistics

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DEPARTMENT OF DEFENSE  
JOINT ORDNANCE TEST PROCEDURE

\* Joint Ordnance Test Procedure (JOTP)-001  
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10 January 2013

HAZARDS OF ELECTROMAGNETIC RADIATION TO  
ORDNANCE (HERO) SAFETY TEST

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## 1. INTRODUCTION.

This document has been developed to address HERO safety testing. It is intended to act as the seminal HERO test procedures among a family of overarching safety procedures for tests simulating common environmental stimuli for the purpose of service assessment and testing of conventional (non-nuclear) munitions.

## 2. SCOPE.

### a. Purpose.

The purpose of this document is to guide personnel involved in the planning and execution of HERO testing and to support joint service approval of the weapon system.

### b. Application.

Data obtained through use of this document should be included in the munition safety data package.

### c. Limitations.

This document is only applicable to conventional (non-nuclear) munitions. This document is not intended to be used to aid the assessment of effectiveness, reliability or performance of a munition.

## 3. TEST CONDITIONS.

### a. Test Item Configuration.

Ordnance may be authorized for use with multiple platform/systems, launchers, interface cables, and diagnostic equipment. All versions of these systems and equipment must be considered for HERO as they can have significant impact on the susceptibility of the ordnance item. Furthermore, it is important to recognize that the ordnance item may be configured differently as it transitions through the various phases of its Stockpile-to-Safe Separation Sequence (S4). Each configuration may, therefore, exhibit significantly different responses to the Electromagnetic Environment (EME); that is, may be very susceptible in one configuration, but completely unresponsive at another. Consequently, all authorized platform/systems, launchers, interface cables, and diagnostic equipment and S4 phases (i.e., transportation/storage, assembly/disassembly, handling/loading, staged, platform loaded, and immediate post-launch) shall be considered as part of the HERO test and/or analysis. Inasmuch as the handling and loading phase (man in the loop) is the most crucial part of the evaluation process, HERO testing shall be conducted during this phase as described in Military Handbook (MIL-HDBK)-240. Relevant ordnance phases involving unrestricted and restricted levels can be found in Military

Standard (MIL-STD)-464C and MIL-HDBK-240 provides detailed explanations and test procedures.

b. Instrumentation.

(1) Electrically Initiated Device (EID) instrumentation shall be capable of detecting and monitoring Radio Frequency (RF)-induced responses of EIDs contained in an ordnance system. As such, the instrumentation sensitivity shall be sufficient to establish the required pass/fail margin (P/FM) when the system is exposed to its expected operational EME. In addition, the instrumentation response time shall be at least as fast as the thermal time constant of the EID being monitored.

(2) During the HERO test, every effort should be made to select and implement an instrumentation package that will not impact the RF characteristics of the ordnance. In addition, the instrumentation system should not be adversely affected by the EME. MIL-HDBK-240 provides discussions on the various types of instrumentation systems used in ordnance testing, characteristics of an instrumentation system, the selection rationale, and other types of instrumentation used for unique non-bridgewire EIDs or firing circuits.

c. Calibration.

The Electromagnetic (EM) energy coupling into an EID is dependent on the impedance matching of the EID bridgewire/circuit and the ordnance system firing circuit. Instrumentation systems shall use the actual EID. Calibrate the instrumentation system by applying a step input of direct current with a duration that is at least 10 times the thermal response time of the EID. An ammeter with at least one-half percent accuracy may be used to measure this pulse. The output of the sensor/transducer is measured and recorded. This output versus input is the calibration for the system. The calibration establishes the relationship of the step input into the EID bridgewire to the output parameter of the instrumentation. This instrumentation output value can then be related to the EID's Maximum No-Fire Stimulus (MNFS) established by the manufacturer or Department of Defense (DoD) agency. The calibration will also establish the instrumentation system's minimum sensitivity and dynamic range. There are three important factors to calibrating the system:

(1) All system components (receiver, recorder, computers, and so forth) that will be used during the test and all component settings must be calibrated.

(2) The direct current pulse must be inputted directly into each individual bridgewire lead or an analysis of the EID circuit must be performed to determine the amount of current applied to the particular bridgewire being monitored.

(3) Calibration data should be obtained for a minimum of five points (50, 25, 10, and 5 percent of the Maximum No Fire Current, and just above the Minimum Detectable Current (MDC) level). However, more calibration points will provide a better approximation of the interpolated data. These points should form a straight line when plotted on logarithmic graph paper.



d. Safety.

Care shall be exercised when performing HERO testing to ensure that personnel are not exposed to excessive RF fields. Furthermore, as the HERO test shall include man-in-the-loop handling and loading procedures, a written Standard Operating Procedure should be included as a part of the test plan to identify the hazards associated with HERO testing and the precautions that should be taken to minimize those hazards. DoDINST 6055.11 of 19 August 2009 provides radiated Maximum Permissible Exposure (MPE) limits, as well as the limits for induced and contact currents, and steps shall be taken to ensure that personnel are not exposed to EME levels that exceed the MPE for personnel.

e. Generating EME Levels.

(1) MIL-STD-464C, Table 9, establishes the HERO test EME requirements. The standard describes two field strength categories, Unrestricted and Restricted. The “restricted” levels in MIL-STD-464C apply for the S4 phases where personnel are present; that is, assembly/disassembly and loading/unloading. All other S4 phases should be evaluated against the “unrestricted” levels.

(2) It may be acceptable to conduct HERO testing at levels less than those indicated in MIL-STD-464C, provided certain conditions are met, as described in MIL-HDBK-240, that allow for the extrapolation of test data to the required level. In order to get a HERO classification of “HERO SAFE ORDNANCE” at the all-up round or appropriate assembly level, the ordnance or system under test (SUT) shall be evaluated against, and be in compliance with, Table 9 of MIL-STD-464C. Compliance shall be verified by test and analysis using the methodology described in MIL-HDBK-240.

f. Maximizing Responses.

To the extent practical, the HERO test shall maximize the response of the instrumented system under test. Both vertical and horizontal polarizations shall be used. To ensure complete illumination, continuous painting of the SUT with radiation is recommended to ensure that maximum responses are determined. Ideally, the item should be illuminated continuously in azimuth and elevation. Ordnance items attached to a large host platform/system should be illuminated over a 180-degree arc, directing the beam toward suspected entry points. For highly directional EM fields, emphasis should be placed on those illumination angles expected to maximize EID response at the predicted points of entry (POE); for example, exposed wiring, enclosure discontinuities, and exposed or poorly shielded cables. In the High Frequency (HF) range, pretest current-ground measurements and knowledge of “worst-case” HF antenna-host platform/system orientations should be taken into account. At microwave frequencies where the illumination angle is narrow, small changes can result in significantly different EID responses; thus, changes in pointing angle should be small and carefully controlled. Changes in illumination angle and polarization should not exceed the response time of the EIDs. Again, the optimum procedure, particularly at frequencies where the radiation pattern is highly directional, is to slowly paint the SUT, making small changes in the elevation and azimuth. MIL-HDBK-240 describes, in detail, test procedures for maximizing responses.

g. Non-Linear Effects.

The HERO test EME is of sufficient magnitude to cause dielectric breakdown between conductors, “arcing”. High RF potentials are generated on ordnance platforms and armament weapons support equipment as well as on ordnance itself. The potentials on these objects equalize when brought into contact with each other. If the potential differences are large enough, an RF arc occurs prior to contact. Under actual or test conditions, arcing will not occur at all frequencies, but will be dependent upon the particular antenna-ordnance item coupling involved. Because of the non-linear nature of RF arcs and the fact that they generally occur in the HF and Very High Frequency (VHF) bands, HERO test results obtained under these conditions cannot be extrapolated to levels above the test field intensities. It is therefore important that all HERO tests in HF and VHF bands are conducted at the required MIL-STD-464C levels or at maximum available field intensities.

4. TESTS.

See MIL HDBK 240: The HERO test shall include the applicable platform; all applicable S4 phases with the man-in-loop performing authorized/likely procedures for authorized handling/loading and assembly/disassembly operations; the use of the HERO test EME found in MIL-STD-464C, Table 9; a minimum of four aspect angles for frequencies between 2 – 30 MHz; horizontal/vertical polarization for frequencies above 30 MHz; and, EID stimulus and firing circuit response measurements including applicable safety/reliability margins.

5. TEST ASSESSMENT AND ANALYSIS REPORT.

a. In order to facilitate data sharing across the Services and to ensure test data consistency and consistent operational guidance, a HERO test report shall be developed as part of every HERO test. In accordance with DOD 6055.09-M, all HERO test reports shall be provided to the Defense Information Systems Agency/Joint Spectrum Center (JSC) for incorporation into the JSC Ordnance Electromagnetic Environmental Effects Risk Assessment Database (JOERAD). At a minimum, HERO test reports shall provide identification of applicable platform(s), system under test, EIDs, EIDs’ maximum no-fire stimulus, EIDs’ bridgewire resistance, EIDs’ firing consequence, and EIDs’ induced stimulus measurement results and resulting Maximum Allowable Environments. HERO test reports shall also provide a National Stock Number/Department of Defense Identification Code/Part No. or other identifying information for the ordnance and a description of the SUT configuration for each S4 phase tested, including the specific loading manual steps accomplished for man-in-loop test procedures. The HERO test report shall also provide a listing of frequency, level, polarization, and aspect angle of each test EME, and extrapolation factor between test EME and MIL-STD-464C, Table 9 EME. MIL-HDBK-240 provides guidance for the preparation of documentation associated with the HERO test program.

b. The results of all HERO testing and analysis conducted relevant to assessing the munitions safety for service shall be compiled into a safety data package for review. The package must include the previously-approved test plan, including the rationale for any variance from the joint requirements. In addition, any deviation from that approved plan shall be presented along with an analysis showing why the results should be accepted. The package must also provide any safety and vulnerability deductions derived from those results.

Comments, suggestions, or questions on this document should be addressed to Range Infrastructure Division (CSTE-TM), US Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001; or e-mailed to:

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